Experiments on some critical aspects of keyboarding

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Psychology can make significant contributions to the problems encountered by those working in industrial settings since analysis and evaluation of the 'human factor' must be of fundamental importance to industrial progress.

All professional disciplines consist broadly of two parts: of theories and laws which represent the consensus of knowledge vested in the subject; and of a compendium of methods and techniques which represent the 'know-how' about the subject. These parts are usually described as the so called 'pure' and 'applied' aspects of professional expertise. Today a distinction between these two can be sustained only by those who have a vested interest in the maintenance of lack of communication between and across all relevant fields of intellectual endeavour. The basic research undertaken in the academic laboratory today finds application on the shop-floor tomorrow. Practice and theory are thus becoming so intertwined as to be indistinguishable and the contributions made by each are such as to be of mutual advantage in their joint development.

A programme of psychological research on keyboarding is at the moment developing at the University of Newcastle upon Tyne. No measurement of speed and errors in keyboarding will have an absolute value, as the results depend on too many variables. We shall enumerate most of these variables to interpret the results of a given measurement in its proper perspective:

Machine factors involve the kind of apparatus in use, both in normal practice and under test conditions for instance, electric or mechanical, with or without hard copy production.

The kind of copy, its quality, presentation, difficulty and familiarity.

Individual ability and level of skill are related:
to individual differences in the skill,
to the time of practice and the mode of practising (for instance by touch using all ten fingers),
to the method of previous training and eventual retraining,
to the knowledge of language, and finally
to temporal fluctuations in output without obvious reason.

The fact of being measured. Results of a measurement can be influenced by:
the length of the test,
nervousness because of uncertainty about its purpose,
because of the comparison with other operators or because of a supervisor being present who expects optimal performance,
anxiety for time measurement as related to wages.

Subjective sets in the operators or special instructions. The instruction can easily be misunderstood, the operator can be over-motivated and thus it is difficult to know whether he puts the stress on speed or on reduction of errors.

Our conclusions are based on the particular situation of the testing while keeping in mind the difference between test and everyday outputs in keyboarding. We shall be content if we can stipulate or possibly assess the relative importance of some of the variables in a controlled way, thus extending the understanding of the skills involved in keyboarding.

The aim at this stage of the study therefore is not to develop predictive tests, but to understand the skill as such. We do not focus on individual differences and ability variables, but we try to isolate components in the skill while minimising individual differences in our sample of subjects for the experiments so that we can detect the elements which are important in keyboarding and therefore have to be regarded in training, selecting and evaluating.

As we do not have enough time to make an extended controlled follow-up study during the first couple of years' improvement in the skills, we shall use three well defined groups of subjects:
starting operators who have just mastered a 'blind' knowledge of the keyboard;
average operators with a fair period of practice; and
the highly skilled operators with considerable practice and top speed.

To explain the gradual increase in skill we shall have to infer the changes from the different results on the three defined levels. As a further specification of our subjects, we would like half the operators to have had the traditional way of training and the other half to be subjected to a recently developed programmed training course such as the one practised by Sight and Sound, this primarily because we are very keen to test our hypotheses concerning the extent of the differences induced by the different ways of reading-in the copy—in blocks, or letter by letter.

In the actual experiments we shall keep all variables constant except for the one that we intend to study. We shall adjust the experimental variable in a systematic way and infer its properties from the changing pattern of results.

In our first experiment we try to reach an estimate of the role of experience in encoding or reading-in of the copy. Instead of measuring the reading speed, we record the anticipation of the next unknown letter on the basis of the letters that are already

seen. The three groups of subjects, the starting, the average and the highly skilled operators, are presented with sequences of letters, each sequence being a different approximation of English, and each time asked to guess the next letter. By counting the number of correct guesses and calculating the average scores for the groups we hope to find if significant differences will appear with higher levels of skills.

Our next experiment tries to assess both the importance of eye-hand span or preview, and the redundancy in the copy as well as their interaction. It is suggested that the value of anticipation is bigger with highly redundant sequences. The purpose of redundancy is to offset negative performance factors as there are errors in the copy, poor discrimination, or too great a task load. It is interesting to test if this role of redundancy is effective for both modes of encoding, in blocks and letter-by-letter.

Our procedure once more is to present all operators with copy of different degrees of redundancy:— normal English, randomly selected words, meaningless sequences of letters with digram frequencies of normal English and finally random sequences of letters. Each test contains 500 strokes. We have constructed a simple device that enables us to limit exactly the number of letters that can be foreseen in the copy. The operator can see for instance three letters that he will have to type. On the moment that he strikes the first letter of these three a fourth letter appears. We vary the length of preview on eye-hand span from unlimited via five letters to one letter. In this last condition the operator therefore sees one letter, reacts to it and thus causes the next letter to appear at the same moment. We are very interested to analyse the interaction between redundancy and preview for both systems of encoding.

Our last experiment can perhaps better be defined as a set-up for a whole range of experiments. In continuous sequential reaction-time tasks like keyboarding, many measures of the speed and movements involved can be made, but clearly the most important measure, and the one most difficult to estimate, is the time between two successive movements.

Peter Fenwick has built a device that can be connected to any IBM Executive typewriter, with the help of which it is possible to record on a punched tape the letters that are typed, as well as the exact time between the two strokes. This tape can be processed by a computer and the required information can be extracted.

This set-up will be of help in analysing the movement-times for digrams in terms of ease of movement and frequency of the digrams. The ease of movements is determined:

by whether or not successive strokes are made by the same finger or hand, and in the same row;

by differences in efficiency of different fingers.

The frequencies of digrams can be estimated from tables representing the number of times that a particular letter is followed by any other letter of the alphabet. We have divided the frequencies in five classes on a logarithmic scale.

It is clear that in this way we can reach some reliable controlled conclusions about the role of the rhythm and the building up of more extended units in keyboarding, eg very frequent words like THE. Special problems, like reaction time to errors, time required for function keys or simultaneously pressing of two keys and time required for error corrections can also be studied very easily in this way.

These are the lines along which we proceed with our research in Newcastle. We hope that the results of these experiments, based as they are on psychological theory, will form a valuable contribution for those who are practising in the field.